Kinetic Theory of Gases:

- Five Assumptions:
  1. The number of molecules in the gas is large, and the average separation between them is large compared with their dimensions.
  2. The molecules obey Newton's laws of motion, but as a whole they move randomly.
  3. The molecules interact only by short-range forces during elastic collisions.
  4. The molecules make elastic collisions with the walls.
  5. The gas under consideration is a pure substance; that is, all molecules are identical.

- Relationship bet. pressure and molecular kinetic energy:

$$P = \frac{2}{3}\left(\frac{N}{V}\right)\left(\frac{1}{2}m\overline{v^2}\right)$$

- Another meaning of temperature:
  - Plug in ideal gas law for last equation, end up with this:

$$\frac{1}{2}m\bar{v}^2 = \frac{3}{2}k_B T$$

  - This tells us that temp. is directly related to kinetic energy

- Molecules can do 3 things:
  - move in x, y, z planes (translate) ① ② ③
  - rotate about some axis ④
  - vibrate ⑤

- Each of these contributes $\frac{1}{2}k_B T$ to the energy of a system.

- Total translational kinetic energy:

$$K = N\left(\frac{1}{2}m\bar{v}^2\right)$$

$$= \frac{3}{2}Nk_B T$$

$$= \frac{3}{2}nRT$$

- RMS speed (root-mean-square):

$$v_{rms} = \sqrt{\frac{3RT}{M}} \qquad M = \text{molar mass} = mN$$

A tank used for filling helium balloons has a volume of 0.300 m^3 and contains 2.00 mol of helium gas at 20 degrees C. Assume the helium behaves like an ideal gas.
a) What is the total translational kinetic energy of the gas molecules?
b) What is the average kinetic energy per molecule?

a) $K = \frac{3}{2} nRT$

$= \frac{3}{2}(2 \text{ mol})(8.31 \text{ J/mol}\cdot\text{K})(293 \text{ K})$

$= 7300 \text{ J}$

b) $K = \frac{3}{2} k_B T$

$= \frac{3}{2}(1.38\text{E-23 J/K})(293 \text{ K})$

$= 6.07\text{E-21 J}$

Definitions of Heat:

1: $Q = \Delta E = -(E_f - E_i)$

- loss of mechanical energy is heat

2: $Q = (\text{Power})(\text{time})$

- electrical or mechanical device to put heat into a system

3: $Q = mc\Delta T$

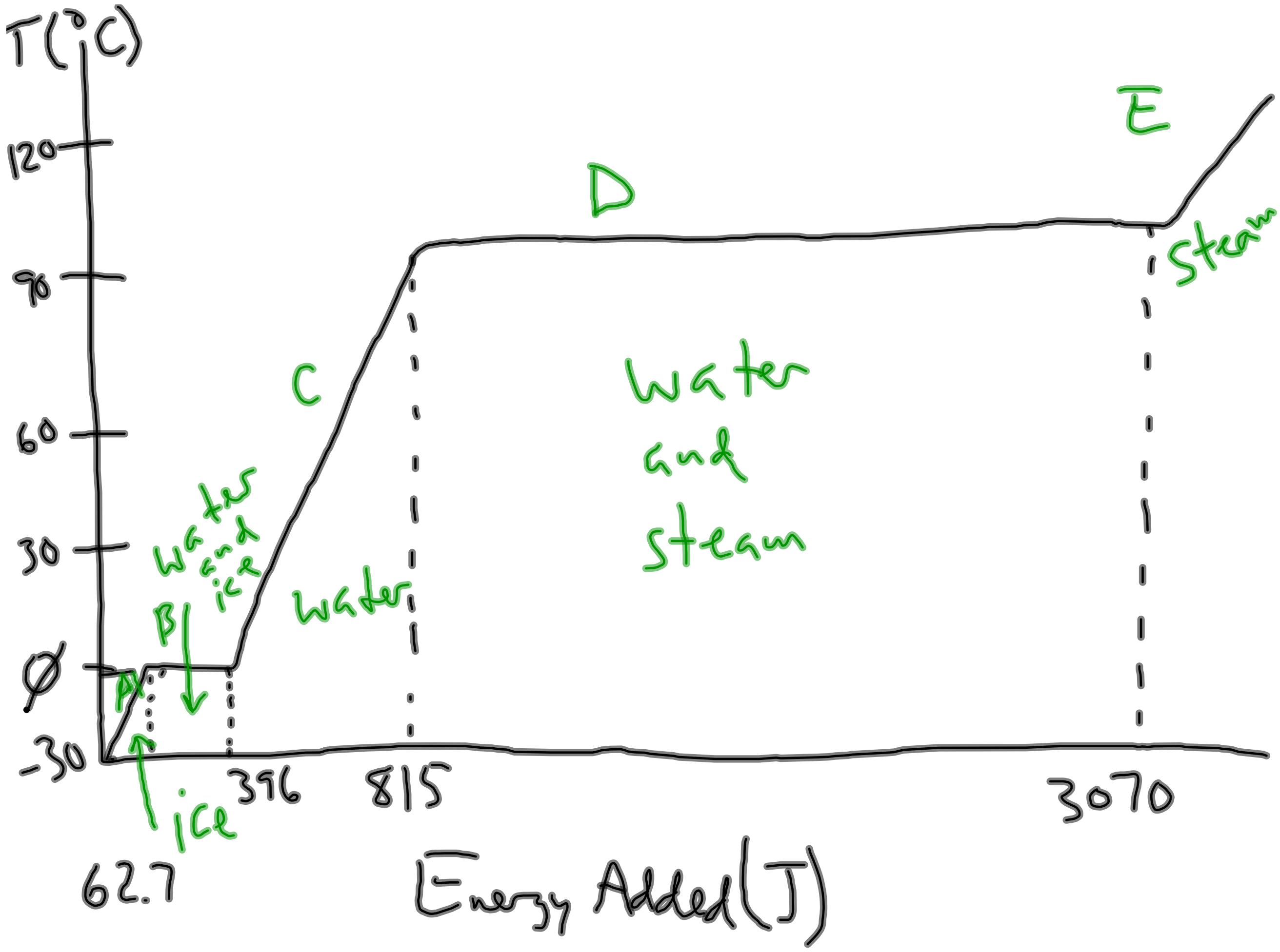
$= mc(T_f - T_i)$

$c \equiv$ specific heat capacity

4: $Q = mL$

$L \equiv$ latent heat

add or subtract heat to substance and have it not change temperature



solid/liquid → latent heat of fusion

liquid/gas → latent heat of vaporization

- Calorimetry:

$$Q_{cold} = -Q_{hot}$$